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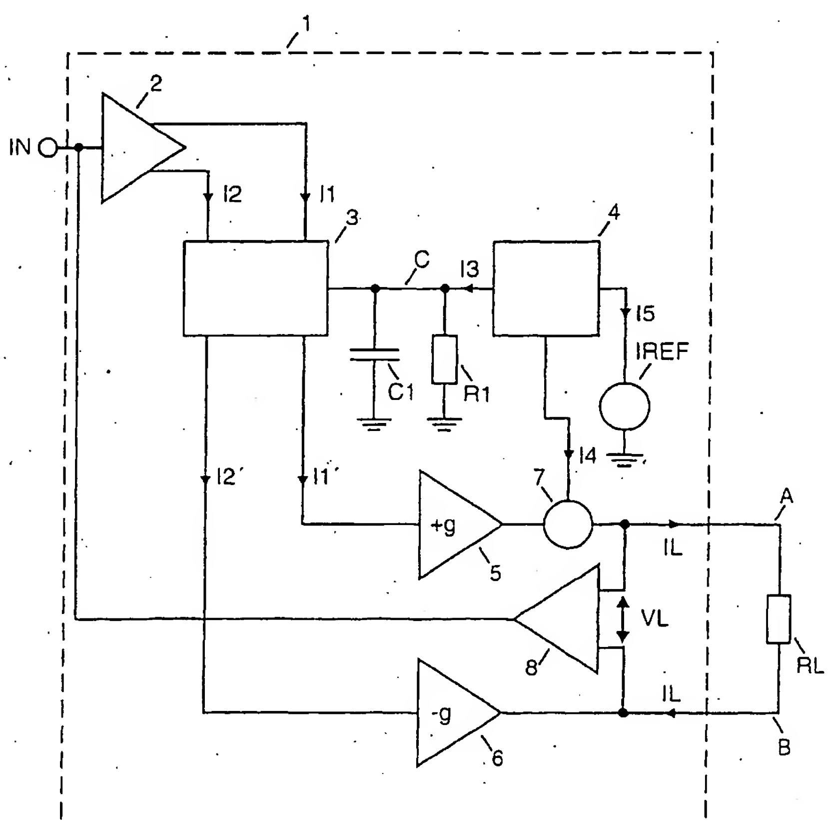
(54) Title: METHOD AND ARRANGEMENT FOR LIMITING A RINGING CURRENT



(57) Abstract: A ringing current (IL) in a subscriber Line interface circuit (1) is limited to a desired maximum value (I5) by a ringing current attenuator (3) having a control input terminal connected to a control output terminal of a current comparator (4). The comparator (4) compares a sensed value (I4) of the ringing current with the desired maximum value (I5). In response to that the sensed value (I4) exceeds the desired maximum value (I5), the attenuator (3) is controlled to reduce the ringing current such that its peak value is kept equal to or below the desired maximum value.

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METHOD AND ARRANGEMENT FOR LIMITING A RINGING CURRENT

TECHNICAL FIELD

The invention relates generally to subscriber line interface circuits (SLICs) and more specifically to ringing current limitation in SLICs.

BACKGROUND OF THE INVENTION

To comply with ringing specifications, a SLIC with integrated ringing must be able to apply a desired constant ringing voltage to a two-wire transmission line to which a subscriber station is connected.

The ringing voltage is applied across the subscriber station resistance, also called ringing load, in series with the transmission line resistance. Depending on the values of the ringing load and the line resistance, the ringing voltage causes a ringing current to flow in the transmission line.

The value of the ringing load is expressed as a Ring Equivalent Number (REN) that can vary between 0.1 REN and 5 REN, where 1 REN is about 7 kΩ.

When the subscriber station goes off-hook, a low-resistance load is connected in parallel with the ringing load inside the subscriber station, thereby reducing the subscriber station resistance. Since the ringing voltage is constant, the ringing current will increase and this condition will remain until the ringing signal is turned off.

To save chip area, it is desired to be able to use the output stages of the SLIC to generate the ringing signal. The necessary currents and voltages are within the operating range of the output stages. Normally, the output stages of the SLIC are used to supply current and speech signals to the subscriber station.

The SLIC is designed as a voltage amplifier and provides a desired ringing voltage. The ringing current is the ringing voltage divided by the load of the two-wire circuit.

To generate a ringing signal, the output stages of the SLIC have to output a current of up to 100 mA. At an off-hook condition, i.e. when a low-resistance load in the subscriber station is connected in parallel with the ringing load, the ringing current will increase up to 300 mA. This causes a problem in the SLIC in that the power generated in the output stages can cause damage to them. The same is true in case of a fault condition, e.g. upon an unintentional grounding of one of the wires of the two-wire transmission line.

Thus, there is a need of ringing current limitation in SLICs in order to protect them.

SUMMARY OF THE INVENTION

The object of the invention is to provide a method and an arrangement for ringing current limitation in a SLIC to limit the ringing current to a value just above the desired ringing current. The ringing current limitation method and arrangement should also quickly reduce the off-hook current or fault condition current and keep it at the desired level until the ringing signal is turned off.

This is attained according to the invention in that the ringing current is sensed relative to a reference current and reduced if it exceeds the reference current. The reference current is so chosen that there is no risk of damaging the output stages.

Thus, when a ringing current is injected into the SLIC, amplified and outputted to the two-wire circuit, it will be detected whether or not the ringing current exceeds the reference current, and if so, the ringing current will be reduced to a peak value equal to or below the reference current.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described more in detail below with reference to the appended drawing on which Fig. 1 is a block diagram of an embodiment of a ringing current limitation arrangement according to the invention in a schematically illustrated SLIC, and Figs. 2a and 2b illustrate waveforms in different nodes in the arrangement in Fig. 1.

DESCRIPTION OF THE INVENTION

Fig. 1 schematically shows a SLIC 1 connected to wires A and B of a two-wire transmission line to a subscriber station (not shown). A load RL connected to the wires A and B in Fig. 1 represents a sum of the line resistance and the ringing load of the subscriber station.

An AC ringing signal intended for the subscriber station is injected into the SLIC 1 via an input terminal IN that is connected to an input terminal of a current amplifier 2. The current amplifier 2 has two output terminals and is adapted to output equal currents I1 and I2 to respective input terminals of a controllable current attenuator 3. The current attenuator 3 has one control input terminal connected via a node C to an output terminal of a current comparator 4, and two output terminals connected to input terminals of respective current amplifiers 5 and 6.

The node C is connected to ground via a capacitor C1 in parallel with a resistor R1. The control input of the current attenuator 3 is of a high resistance. Thus, the current attenuator 3 is controlled by the voltage in node C.

The current attenuator 3 is adapted to output equal ringing currents I1' and I2' that are attenuated versions of the input currents I1 and I2, respectively, in response to the voltage in node C. In the absence of a voltage in node C, I1' = I1 and I2' = I2.

The current amplifiers 5 and 6 are adapted to amplify the ringing currents I1' and I2' by amplification factors +g and –g, respectively, before ringing currents IL and –IL, respectively, are applied to the wires A and B via the output terminals of the respective current amplifier 5 and 6.

A voltage controlled current source 8 is connected with its input terminals to the wires A and B, respectively, and with its output terminal to the input terminal of the current amplifier 2. The voltage controlled current source 8 senses the line voltage VL across the

load RL and feeds a phase-inverted signal back to the current amplifier 2. Hereby, a fixed amplification is obtained between the injected ringing signal and the line voltage VL. Consequently, the ringing current IL will increase when the load RL is decreased e.g. when the subscriber station goes off-hook.

In accordance with the invention, a value of the ringing current IL is sensed by means of a current sensor 7 that, in the embodiment in Fig. 1, is interconnected between the output terminal of the current amplifier 5 and the wire A to sense an actual value of the ringing current IL.

However, it is to be understood that a value of the ringing current equally well can be sensed in another node as long as the relationship to the actual ringing current IL is known, e.g. on the input terminal of the current amplifier 5 where I1' = IL/g, i.e. where a portion of the ringing current IL is sensed.

The current sensor 7 is adapted to output a rectified version I4 of the ringing current IL to one input terminal of the current comparator 4. Another input terminal of the current comparator 4 is connected to a reference DC current source IREF that is adapted to output a fixed reference current I5. The reference current I5 represents the maximum allowable peak value of the ringing current IL and is set such that there is no risk for the ringing current to damage the output stages, i.e. the current amplifiers 5 and 6.

It should be pointed out that, if the ringing current is sensed on the input terminal of the current amplifier 5 as mentioned above, the reference DC current source IREF has to be scaled down to output the reference current I5/g.

If the current I4 exceeds the reference current I5, the current comparator 4 outputs a control current I3 to the node C. The current I3 charges the capacitor C1 and the capacitor C1 is discharged towards ground through the resistor R1.

The voltage caused by the current I3 in the node C, i.e. on the control input terminal of the current attenuator 3, controls the current attenuator 3 to attenuate the ringing currents I1 and I2 in proportion to the value of the voltage. The current I3 will be outputted by the current comparator 4 as long as the current I4 exceeds the reference current I5.

With reference to Figs. 2a and 2b, the operation of the embodiment of the ringing current limiting arrangement according to the invention, shown in Fig. 1 will be described.

Fig. 2a is a diagram of the rectified ringing current I4 supplied by the current sensor 7 to the current comparator 4 to be compared with the reference current I5 provided by the DC current source IREF.

At time t0, the subscriber station goes off-hook. As mentioned in the introductory portion above, a low-resistance load in the subscriber station is then connected in parallel with the ringing load and the ringing current IL will increase. This increase of the ringing current IL will cause a corresponding increase of the rectified current I4 as apparent from Fig. 2a.

At time t1, the amplitude of the rectified current I4 exceeds the reference current I5 and the current comparator 4 begins to generate the current I3. The current I3 causes the voltage VC in the node C to start to increase from zero or ground as shown in Fig. 2b. This increase of the voltage VC will continue as long as I4>I5. The voltage VC in the node C, i.e. on the control input terminal of the current attenuator 3, causes the current attenuator 3 to attenuate the ringing currents I1 and I2, thereby lowering their amplitudes.

At time t2, I4<I5. At that time, the discharge of the capacitor C1 to a lower voltage value begins as illustrated in Fig. 2b.

During the next half-period of the ringing current, the peak value of I4 has been attenuated as apparent from Fig. 2a but still it exceeds I5. Thus, the capacitor C1 is

further charged by the current I3 and the current attenuator 3 is caused to further attenuate the ringing currents I1 and I2.

At time t3, the peak value of I4 is supposed to equal I5.

Thus, the ringing current has very quickly been attenuated to a value that has been set such that there is no risk for the current amplifiers 5 and 6 to be damaged.

CLAIMS

1. A method of limiting a ringing current in a subscriber line interface circuit to a maximum value, **characterized by**
- sensing a value of the ringing current and comparing it with the maximum value to detect when the sensed value exceeds the maximum value,
- in response to that the sensed value exceeds the maximum value, generating a signal that is proportional to the difference between the sensed value and the maximum value, and
- attenuating the ringing current in response to said signal such that its peak value is kept equal to or below the maximum value.

2. The method according to claim 1, **characterized by** sensing an actual value of the ringing current.

3. An arrangement for limiting a ringing current in a subscriber line interface circuit to a maximum value, **characterized in** that it comprises a ringing current attenuator (3) having a control input terminal connected to a control output terminal of a current comparator (4), the comparator (4) being adapted to compare a sensed value of the ringing current with the maximum value and, in response to that the sensed value exceeds the maximum value, to supply to the attenuator (3) a control signal that is proportional to the difference between the sensed value and the maximum value to reduce the ringing current such that its peak value is kept equal to or below the maximum value.

4. The arrangement according to claim 3, **characterized in** that the sensed value is an actual value of the ringing current.

5. An arrangement for limiting a ringing current in a subscriber line interface circuit (1), comprising a first current amplifier (2) having an input terminal (IN) for receiving the ringing current, and two output terminals for outputting equal currents (I1, I2) to input terminals of a pair of second current amplifiers (5, 6) whose output terminals are

connected to respective wire of a two-wire circuit to a subscriber station (RL) for receiving the ringing current, **characterized in** that a current sensor (7) is provided to sense the ringing current (IL) or a portion thereof and to generate a rectified copy (I4) of the sensed current (IL) on an output terminal connected to one input terminal of a current comparator (4), the current comparator (4) having another input terminal connected to a reference current source (IREF) generating a reference current (I5), and an output terminal connected to a control input terminal of a current attenuator (3) interconnected between the output terminals of said first current amplifier (2) and the input terminals of said pair of second current amplifiers (5, 6), the current comparator (4) being adapted to supply a control current (I3) to the current attenuator (3) when the sensed current (IL) exceeds the reference current (I5) to attenuate said equal currents (I1, I2) in correspondence to the difference between the sensed current (IL) and the reference current (I5).

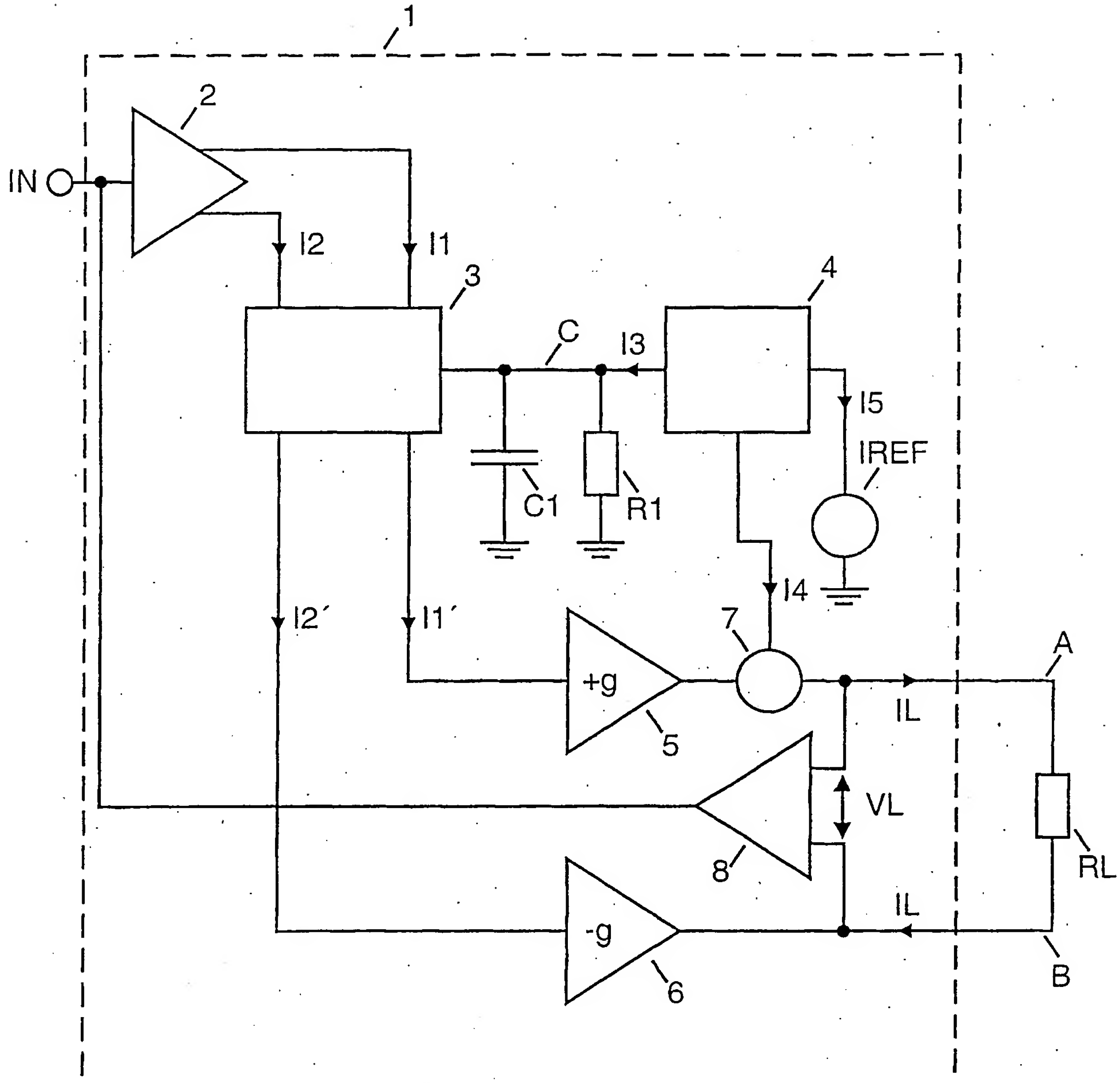

Fig. 1

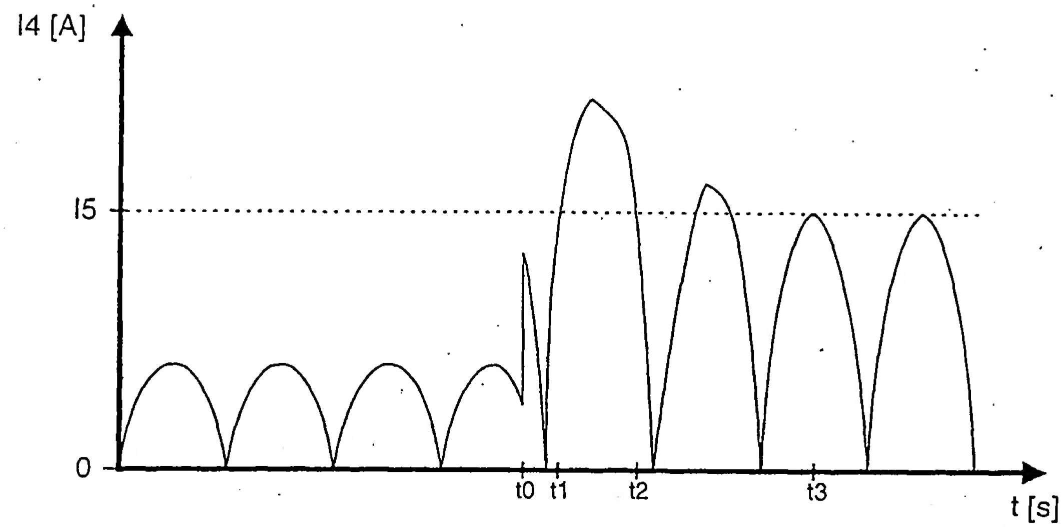

Fig. 2a

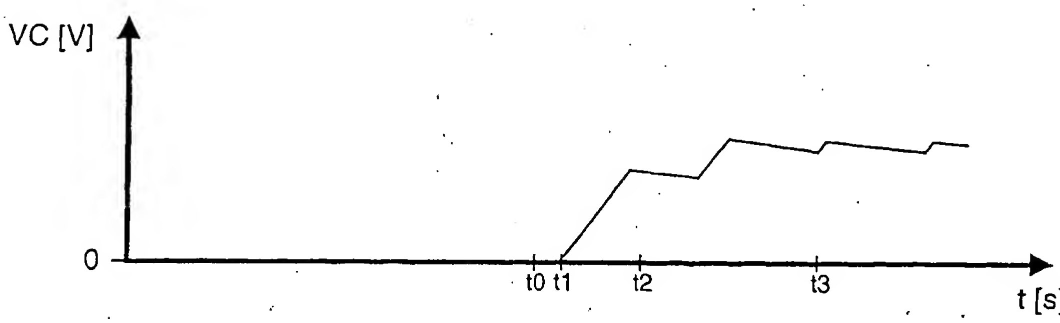

Fig. 2b